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Scented Multi-Layered Finishes for Metal Substrates

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SCENTED MULTI-LAYERED FINISHES FOR METAL SUBSTRATES

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FIELD

This disclosure relates to the fields of coatings, material science, material chemistry, metallurgy, aluminum alloys, and related fields. More specifically, the disclosure provides novel scented multi-layered finishes for metal substrates that can be used in can applications, among other applications.

BACKGROUND

Scent can enhance a consumer's experience with a product. Scent can uniquely identify a source of a good or flavor of a good to a consumer. In addition, consumers may be attracted to a certain brand based on the aesthetic qualities, including scent, of the container used for the product.

SUMMARY

Described herein are scented multi-layered finish-coated substrates, coating systems for preparing scented multi-layered finishes, and methods of applying scented multi-layered finishes to substrates, such as metal substrates. In some cases, the scented multi-layered finishes include a fragrance in a top coating layer of the finish. A scented multi-layered finish-coated substrate can include a metal substrate, a base coating layer adhered to the metal substrate, and a top coating layer (e.g., a clear coating layer) comprising at least one fragrance. The clear coating layer can be adhered to the base coating layer. In some examples, the fragrance comprises an oil (e.g., an essential oil). In some examples, the fragrance comprises a wax, a slurry, or a powder. Optionally, the fragrance oil or powder may be encapsulated. In certain examples, the fragrance may comprise an herbal scent, a fruit scent, a nature scent, a floral scent, or a spice scent. Optionally, the metal substrate comprises an aluminum substrate. The aluminum substrate can optionally comprise a 3xxx series aluminum alloy or a 5xxx series aluminum alloy. The aluminum substrate can optionally be a beverage can end. The base coating layer can include a pigment and/or a dye. In certain examples, the base coating layer may visually coordinate with a

fragrance. For example, the base coating layer may be orange in color and the fragrance may be an orange scent. Optionally, the base coating layer can include a printed pattern.

A coating system comprising a base coating component and a clear coating component comprising at least one fragrance is also described herein. The concentration of the fragrance in the clear coating component can be at least about 0.5 % based on the weight of the clear coating component (e.g., from about 1 % to about 5 % based on the weight of the clear coating component). In certain examples, the concentration of the fragrance can be up to about 25 % based on the weight of the clear coating component.

Further described herein are scented multi-layered finish-coated metal products and coating systems used to prepare the finishes, wherein the finishes display a print or pattern and include a fragrance. In some examples, a scented multi-layered finish-coated metal product comprises a metal substrate, a base coating layer, a printed coating layer, and a clear coating layer. The base coating layer is adhered to the metal substrate. The printed coating layer is adhered to the base coating layer and the clear coating layer. Optionally, the metal substrate comprises an aluminum substrate. The aluminum substrate can optionally comprise a 3xxx series aluminum alloy or a 5xxx series aluminum alloy. The aluminum substrate can be a beverage can end or another aluminum substrate. Optionally, the printed coating layer exhibits a wood-grain effect, a fruit effect, or an animal print effect. The clear coating layer can comprise a fragrance. In some cases, the scent of the fragrance may coordinate with visual aspects of the printed coating layer based on a consumer's expectations. For example, the printing coating layer may exhibit a wood-grain effect and the coordinating fragrance may be pine or cedar. In other examples, the printed coating layer may include fruits and the coordinating fragrance may be a fruit scent (e.g., a strawberry print as the printed coating layer and a strawberry fragrance as the fragrance in the clear coating layer).

Methods of applying a scented multi-layered finish to a metal substrate surface are also described herein. A non-limiting exemplary method of applying a multi-layered finish to a metal substrate surface comprises applying a base coating component to the metal substrate surface, drying the base coating component to form a base coating layer, applying a clear coating component comprising a fragrance to the base coating layer, and drying the clear coating component to form a clear coating layer. Optionally, the thickness of the base coating layer can

be from about 0.1 μm to about 15 μm. Optionally, the thickness of the clear coating layer can be from about 1 μm to about 20 μm.

The method can further comprise a step of applying and drying a third coating component to form a third coating layer. The applying and drying the third coating component step can be performed after the step of drying the base coating and before the step of applying the clear coating component. Optionally, the third coating component may comprise a printed coating component. Optionally, the finish can be applied to aluminum products. For example, the finish can be applied to a can end (e.g., a beverage can end) or other aluminum products.

Also described herein are scented multi-layered finish-coated metal products comprising a metal substrate, a base coating layer adhered to the metal substrate, and a clear coating layer comprising a fragrance, wherein a coat weight of the clear coating layer is from about 0.1 g/m^2 to about 10.0 g/m^2 (e.g., from about 5.0 g/m^2 to about 8.0 g/m^2). Optionally, the metal substrate comprises a metal substrate (e.g., an aluminum substrate). The aluminum substrate can be a beverage can end (e.g., a 200 can end, a 202 can end, a 206 can end, or a 209 can end) or a beverage can tab. Optionally, the base coating layer comprises a pigment or a dye. Optionally, the multi-layered finish-coated metal product can further comprise a third coating layer.

Methods of applying a scented multi-layered finish to a metal substrate surface are also described herein. The methods comprise applying a base coating component to the metal substrate surface, drying the base coating component to form a base coating layer, applying a clear coating component comprising at least one fragrance, and drying the clear coating component to form a clear coating layer, wherein a coat weight of the clear coating layer is from about 0.1 g/m^2 to about 10.0 g/m^2 (e.g., from about 5.0 g/m^2 to about 8.0 g/m^2). Optionally, the methods can further comprise adding an additional fragrance to the clear coating component. Optionally, the methods can further comprise applying and drying a third coating component to form a third coating layer. The step of applying and drying the third coating component can be performed after the step of drying the base coating component and before the step of applying the clear coating component comprising a fragrance.

Other objects, aspects, and advantages will become apparent upon consideration of the following detailed description of non-limiting examples and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of a metal substrate with a base coating layer and a top coating layer according to one disclosure described herein.

FIG. 2 is an illustration of a metal substrate with a base coating layer, a printed layer, and a top coating layer according to one disclosure described herein.

FIG. 3A is an illustration of a top coating layer comprising fragrance microcapsules according to one disclosure described herein.

FIG. 3B is an illustration of a fragrance microcapsule of FIG. 3A.

FIG. 3C is an illustration of a fragrance microcapsule in a release state according to one disclosure described herein.

FIG. 3D is an illustration of a fragrance microcapsule in a release state according to one disclosure described herein.

DETAILED DESCRIPTION

Provided herein are scented multi-layered finish-coated substrates, coating systems for preparing scented multi-layered finishes, and methods of applying scented multi-layered finishes to substrates. Suitable substrates for coating with the finishes described herein include metal substrates (e.g., aluminum, steel, stainless steel, copper, or magnesium substrates). As used herein, the substrate is considered to be coated when a finish component is in contact with at least a portion of a surface of the substrate. Optionally, the entirety of a surface of a substrate can be coated with a finish component as described herein. Optionally, more than one surface of a substrate can be coated with a finish component as described herein. Suitable substrates include substrates in the can industry (e.g., can end stock), among others.

Coating Systems and Coated Substrates

Described herein are coating systems that can be used to prepare scented multi-layered finishes on a substrate. In some examples, the coating systems can include a fragrance within a top coating layer as the outermost layer, thereby producing scented-coating finishes. In some cases, the top coating layer is a clear coating layer. In some cases, the coating systems can include a printed layer beneath the clear coating layer. The coating systems also include a base coating layer in contact with the substrate. The scented-coating finishes, along with substrates coated with such finishes, are further described below.

Coated Substrates

A scented multi-layered finish can be prepared from a coating system that includes a base coating layer and a top coating layer (e.g., a clear coating layer) comprising a fragrance. The base coating layer is prepared from a base coating component. The base coating component can include any component conventionally used in a base coating composition, including polymers such as acrylic polymers or polyesters. Optionally, the base coating component can include one or more crosslinking agents. The base coating component can also include a pigment or dye. For example, the base coating component can include metallic oxides (e.g., titanium dioxide, zinc oxide, and iron oxide), carbon black, organic pigments and dyes, metallic flake pigments, filler pigments, and silica. The base coating component can further include a carrier, such as an aqueous or a solvent-based carrier. Optionally, the base coating component can include a printed pattern.

The top coating layer (e.g., the clear coating layer) that includes a fragrance can be adhered to the base coating layer, such that the top coating layer is the outermost layer of the finish (e.g., the layer of the finish exposed to the environment or to a substance contained within a metal product). The clear coating layer is prepared from a clear coating component and a fragrance, such as one or more essential oils or other artificial or natural fragrances and as further described below. The clear coating component can include polymers, such as, but not limited to, an epoxy or polyester resin. The clear coating component can further include a carrier, such as, but not limited to, an aqueous or a solvent-based carrier.

The coat weight for the clear coating layer can be from about 0.1 g/m^2 to about 10.0 g/m^2 (e.g., from about 1.0 g/m^2 to about 9.0 g/m^2 or from about 2.0 g/m^2 to about 8.0 g/m^2). For example, the coat weight for the clear coating layer can be about 0.1 g/m^2, about 0.5 g/m^2, about 1.0 g/m^2, about 1.5 g/m^2, about 2.0 g/m^2, about 2.5 g/m^2, about 3.0 g/m^2, about 3.5 g/m^2, about 4.0 g/m^2, about 4.5 g/m^2, about 5.0 g/m^2, about 5.5 g/m^2, about 6.0 g/m^2, about 6.5 g/m^2, about 7.0 g/m^2, about 7.5 g/m^2, about 8.0 g/m^2, about 8.5 g/m^2, about 9.0 g/m^2, about 9.5 g/m^2, or about 10.0 g/m^2 or anywhere in between. The coat weight used for the clear coating component can protect the base coating layer or intervening layer from excessive abrasion and can also protect the tooling used in making and forming the aluminum product into its end use form.

The finish can be applied to metal substrates and can be used to coat metal substrates, such as aluminum, an aluminum alloy, magnesium, a magnesium-based material, titanium, a titanium-based material, copper, a copper-based material, steel, a steel-based material, stainless steel, bronze, a bronze-based material, brass, or a brass-based material. In some cases, the aluminum substrate is a 3xxx series aluminum alloy or a 5xxx series aluminum alloy, although the aluminum substrate could be any suitable series aluminum alloy. Suitable 3xxx series aluminum alloys include, for example, AA3002, AA3102, AA3003, AA3103, AA3103A, AA3103B, AA3203, AA3403, AA3004, AA3004A, AA3104, AA3204, AA3304, AA3005, AA3005A, AA3105, AA3105A, AA3105B, AA3007, AA3107, AA3207, AA3207A, AA3307, AA3009, AA3010, AA3110, AA3011, AA3012, AA3012A, AA3013, AA3014, AA3015, AA3016, AA3017, AA3019, AA3020, AA3021, AA3025, AA3026, AA3030, AA3130, and AA3065.

Suitable 5xxx series aluminum alloys include, for example, AA5005, AA5005A, AA5205, AA5305, AA5505, AA5605, AA5006, AA5106, AA5010, AA5110, AA5110A, AA5210, AA5310, AA5016, AA5017, AA5018, AA5018A, AA5019, AA5019A, AA5119, AA5119A, AA5021, AA5022, AA5023, AA5024, AA5026, AA5027, AA5028, AA5040, AA5140, AA5041, AA5042, AA5043, AA5049, AA5149, AA5249, AA5349, AA5449, AA5449A, AA5050, AA5050A, AA5050C, AA5150, AA5051, AA5051A, AA5151, AA5251, AA5251A, AA5351, AA5451, AA5052, AA5252, AA5352, AA5154, AA5154A, AA5154B, AA5154C, AA5254, AA5354, AA5454, AA5554, AA5654, AA5654A, AA5754, AA5854, AA5954, AA5056, AA5356, AA5356A, AA5456, AA5456A, AA5456B, AA5556, AA5556A, AA5556B, AA5556C, AA5257, AA5457, AA5557, AA5657, AA5058, AA5059, AA5070, AA5180, AA5180A, AA5082, AA5182, AA5083, AA5183, AA5183A, AA5283, AA5283A, AA5283B, AA5383, AA5483, AA5086, AA5186, AA5087, AA5187, and AA5088.

In some examples, the finish can be applied to a can end (e.g., a beverage can end), a can tab, or other desired product. Can ends of all sizes are suitable for use as the substrate. For example, the can end can be a 200 can end, a 202 can end, a 206 can end, or a 209 can end.

The coating system can be applied to a substrate to form a scented multi-layered finish-coated substrate. The scented multi-layered finish-coated substrate includes a substrate, a base coating layer, and a clear coating layer that includes a fragrance. The base coating layer is adhered to the substrate. Optionally, the scented multi-layered finish-coated substrate includes a

third coating layer. In some cases, the scented multi-layered finish-coated substrate includes a substrate, a base coating layer having a first surface and a second surface, a clear coating layer having a first surface and a second surface, where the clear coating layer includes a fragrance, and a third coating layer having a first surface and a second surface. Optionally, the first surface of the base coating layer can be adhered to the substrate and the second surface of the base coating layer can be adhered to the first surface of the third coating layer. The second surface of the third coating layer can be adhered to the first surface of the clear coating layer. Optionally, the first surface of the base coating layer can be adhered to the substrate and the second surface of the base coating layer can be adhered to the first surface of the clear coating layer. The second surface of the clear coating layer can be adhered to the first surface of the third coating layer.

Fragrances

A fragrance can be added to a coating system that includes a base coating and a coating for use as the top coating (e.g., a clear coating). The top coating (e.g., clear coating) can include more than one fragrance. Optionally, the fragrance can be in the form of an oil, a wax, a slurry, a powder, or other forms known to those skilled in the art. Optionally, the fragrance can include essential oils, such as sweet orange or lemon. Essential oils may be volatile and readily evaporate at ambient conditions. As used herein, the meaning of "ambient conditions" can include temperatures of about room temperature, relative humidity of from about 20 % to about 100 %, and barometric pressure of from about 975 millibar (mbar) to about 1050 mbar. For example, relative humidity can be about 20 %, about 21 %, about 22 %, about 23 %, about 24 %, about 25 %, about 26 %, about 27 %, about 28 %, about 29 %, about 30 %, about 31 %, about 32 %, about 33 %, about 34 %, about 35 %, about 36 %, about 37 %, about 38 %, about 39 %, about 40 %, about 41 %, about 42 %, about 43 %, about 44 %, about 45 %, about 46 %, about 47 %, about 48 %, about 49 %, about 50 %, about 51 %, about 52 %, about 53 %, about 54 %, about 55 %, about 56 %, about 57 %, about 58 %, about 59 %, about 60 %, about 61 %, about 62 %, about 63 %, about 64 %, about 65 %, about 66 %, about 67 %, about 68 %, about 69 %, about 70 %, about 71 %, about 72 %, about 73 %, about 74 %, about 75 %, about 76 %, about 77 %, about 78 %, about 79 %, about 80 %, about 81 %, about 82%, about 83 %, about 84 %, about 85 %, about 86 %, about 87 %, about 88 %, about 89 %, about 90 %, about 91 %, about 92 %, about 93 %, about 94 %, about 95 %, about 96 %, about 97 %, about 98 %, about 99 %, or about

100 %. For example, barometric pressure can be about 975 mbar, about 980 mbar, about 985 mbar, about 990 mbar, about 995 mbar, about 1000 mbar, about 1005 mbar, about 1010 mbar, about 1015 mbar, about 1020 mbar, about 1025 mbar, about 1030 mbar, about 1035 mbar, about 1040 mbar, about 1045 mbar, or about 1050 mbar. As used herein, the meaning of "room temperature" can include a temperature of from about 15 °C to about 30 °C, for example about 15 °C, about 16 °C, about 17 °C, about 18 °C, about 19 °C, about 20 °C, about 21 °C, about 22 °C, about 23 °C, about 24 °C, about 25 °C, about 26 °C, about 27 °C, about 28 °C, about 29 °C, or about 30 °C.

In some cases, the fragrance can be dispersed throughout the top coating layer. In some examples, the fragrance may be microencapsulated. In some examples, the microcapsules may be embedded within the clear coating layer. In some cases, the microcapsules may release a portion of the encapsulated fragrance through pores of the encapsulating material. The amount of fragrance released from the encapsulating material may differ based on ambient conditions and the amount of force applied to the microcapsule. In some examples, a microcapsule may release the fragrance due to increased temperature. At elevated temperatures, the fragrance within the microcapsule can thermally expand, increasing the pressure within the microcapsule, and increasing the amount of fragrance released. In some examples, a microcapsule may release the fragrance due to external pressure or friction on the microcapsule directly or on the coating layer comprising the microcapsule. The microcapsule may deform allowing a portion of the encapsulated fragrance to be released. In certain examples, the microcapsule may rupture allowing more of the encapsulated fragrance to be released. In some cases, the volatility and olfactory response associated with fragrance compounds can allow for an encapsulated fragrance to be released, pass through the top coating layer, and be detected. In certain examples, the fragrance may be released by rubbing or applying force to the top coating layer that includes fragrance microcapsules.

In some examples, the fragrance may include herbal scents such as lavender, peppermint, spearmint, citronella, eucalyptus, jasmine, rosemary or others. In some examples, the fragrance may include fruit scents such as orange, lemon, strawberry, apple, grape, watermelon, grapefruit, tangerine, mandarin, lime, cherry, coconut, banana, kiwi, pineapple, pear, blueberry, peach or others. In some examples, the fragrance may include spice scents such as clove, vanilla, ginger, cinnamon or others. In some examples, the fragrance may include nature scents such as cypress,

pine, camphor, sandalwood, rose, orchid, honey, magnolia, cedar or others. In some examples, the fragrance may include floral scents.

The concentration of the fragrance(s) may be at least about 0.1 % or at least about 0.5 % based on the weight of the clear coating component (e.g., from about 0.1 wt. % to about 25 wt. %, from about 0.5 wt. % to about 10 wt. %, or from about 1 wt. % to about 5 wt. %). Optionally, the concentration of the fragrance can be up to about 25 % based on the weight of the clear coating component. For example, the concentration of the fragrance can be about 0.1 wt. %, about 0.2 wt. %, about 0.3 wt. %, about 0.4 wt. %, about 0.5 wt. %, about 0.6 wt. %, about 0.7 wt. %, about 0.8 wt. %, about 0.9 wt. %, about 1.0 wt. %, about 1.5 wt. %, about 2.0 wt. %, about 2.5 wt. %, about 3.0 wt. %, about 3.5 wt. %, about 4.0 wt. %, about 4.5 wt. %, about 5.0 wt. %, about 5.5 wt. %, about 6.0 wt. %, about 6.5 wt. %, about 7.0 wt. %, about 7.5 wt. %, about 8.0 wt. %, about 8.5 wt. %, about 9.0 wt. %, about 9.5 wt. %, about 10.0 wt.%, about 10.5 wt. %, about 11.0 wt. %, about 11.5 wt. %, about 12.0 wt. %, about 12.5 wt. %, about 13.0 wt. %, about 13.5 wt. %, about 14.0 wt. %, about 14.5 wt. %, about 15.0 wt. %, about 15.5 wt. %, about 16.0 wt. %, about 16.5 wt. %, about 17.0 wt. %, about 17.5 wt. %, about 18.0 wt. %, about 18.5 wt. %, about 19.0 wt. %, about 19.5 wt. %, about 20.0 wt. %, about 20.5 wt. %, about 21.0 wt. %, about 21.5 wt. %, about 22.0 wt. %, about 22.5 wt. %, about 23.0 wt. %, about 23.5 wt. %, about 24.0 wt. %, about 24.5 wt. %, or about 25.0 wt. % or anywhere in between based on the weight of the clear coating component. Optionally, the concentration of the fragrance can be from about 0.5 wt. % to about 3.0 wt. % based on the weight of the clear coating component. The amount of fragrance in the clear coating component, which in turn will be present in the clear coating layer, can be adjusted to achieve the desired effect in the product. Optionally, the clear coating component may comprise more than one fragrance.

Turning to the figures, FIG. 1 shows a scented multi-layer coating 100 on metal substrate 110 according to one example. The multi-layer coating 100 includes a base coating layer 104 adhered to the metal substrate 110 and a top coating layer 102, which in this illustration is a clear coating layer, adhered to the base coating layer 104. FIG. 2 shows a scented multi-layer coating 101 on metal substrate 110 according to one example. The multi-layer coating 101 includes a base coating layer 104 adhered to the metal substrate 110, a third coating layer 103 (which in this illustration is a printed coating layer) adhered to the base coating layer, and a top coating layer 102 adhered to the third coating layer 103.

FIG. 3A is an illustration of a top coating layer 102 comprising fragrance microcapsules 130 according to one example. In FIG. 3A, the fragrance microcapsules 130 are dispersed throughout the polymer 120 of the top coating layer 102. FIGS. 3B and 3C are illustrations of a fragrance microcapsule 130 with (FIG. 3C) and without (FIG. 3B) force applied. In FIG. 3B, the fragrance 135 is bound by wall 140 of the microcapsule 130 when at steady-state. As shown in FIG. 3C, the fragrance 135 may be released from the microcapsule 130 when a force is applied to the microcapsule 130 without rupturing the wall 140 of the microcapsule 130. As shown in FIG. 3D, the fragrance 135 may be released from the microcapsule 130 when the force applied to the microcapsule 130 ruptures the wall 140 of the microcapsule 130.

Method of Applying Coating Finishes

Also described herein is a method for applying a scented finish to a substrate, such as an aluminum product. In some examples, the method comprises applying a base coating component to the surface of a substrate. The base coating component can be applied using any technique, including dipping and/or spraying. The base coating component can be dried to form a base coating layer. The base coating layer has a thickness ranging from about 0.1 μm to about 15 μm (e.g., from about 0.5 μm to about 15 μm or from about 1 μm to about 10 μm). In some examples, the base coating layer can have a thickness of about 0.1 μm, about 0.2 μm, about 0.3 μm, about 0.4 μm, about 0.5 μm, about 0.6 μm, about 0.7 μm, about 0.8 μm, about 0.9 μm, about 1 μm, about 2 μm, about 3 μm, about 4 μm, about 5 μm, about 6 μm, about 7 μm, about 8 μm, about 9 μm, about 10 μm, about 11 μm, about 12 μm, about 13 μm, about 14 μm, or about 15 μm.

A top coating component, such as a clear coating component, can then be applied to the base coating layer or to an intervening layer. The top coating component (e.g., the clear coating component) can include a fragrance in a heterogeneous or homogeneous mixture. The top coating component (e.g., the clear coating component) can then be dried to form a top coating layer (e.g., a clear coating layer).

In some cases, the top coating component (e.g., the clear coating component) can be applied to form a top coating layer (e.g., a clear coating layer) at a coat weight of from about 0.1 g/m^2 to about 10.0 g/m^2 (e.g., from about 1.0 g/m^2 to about 9.0 g/m^2 or from about 2.0 g/m^2 to about 8.0 g/m^2). For example, the top coating component (e.g., the clear coating component) can be applied to form a top coating layer (e.g., a clear coating layer) at a coat weight of about 0.1

g/m^2, about 0.5 g/m^2, about 1.0 g/m^2, about 1.5 g/m^2, about 2.0 g/m^2, about 2.5 g/m^2, about 3.0 g/m^2, about 3.5 g/m^2, about 4.0 g/m^2, about 4.5 g/m^2, about 5.0 g/m^2, about 5.5 g/m^2, about 6.0 g/m^2, about 6.5 g/m^2, about 7.0 g/m^2, about 7.5 g/m^2, about 8.0 g/m^2, about 8.5 g/m^2, about 9.0 g/m^2, about 9.5 g/m^2, or about 10.0 g/m^2 or anywhere in between.

In some cases, the top coating layer (e.g., the clear coating layer) can have a thickness ranging from about 1 μm to about 20 μm (e.g., from about 5 μm to about 15 μm or from about 7 μm to about 12 μm). In some examples, the top coating layer (e.g., clear coating layer) can have a thickness of about 1 μm, about 2 μm, about 3 μm, about 4 μm, about 5 μm, about 6 μm, about 7 μm, about 8 μm, about 9 μm, about 10 μm, about 11 μm, about 12 μm, about 13 μm, about 14 μm, about 15 μm, about 16 μm, about 17 μm, about 18 μm, about 19 μm, or about 20 μm or anywhere in between.

In some examples, the method can include applying a third coating component and drying the third coating component to form a third coating layer. The applying the third coating component and drying the third coating component steps are performed after the step of drying the base coating and before the step of applying the top coating. In some cases, the third coating component includes a printed coating component, which can be dried to form a printed coating layer. The third coating layer (e.g., the printed coating layer) can have a thickness ranging from about 0.1 μm to about 20 μm (e.g., from about 0.5 μm to about 15 μm or from about 1 μm to about 10 μm). In some examples, the third coating layer, such as the printed coating layer, can have a thickness of about 0.1 μm, about 0.2 μm, about 0.3 μm, about 0.4 μm, about 0.5 μm, about 0.6 μm, about 0.7 μm, about 0.8 μm, about 0.9 μm, about 1 μm, about 2 μm, about 3 μm, about 4 μm, about 5 μm, about 6 μm, about 7 μm, about 8 μm, about 9 μm, about 10 μm, about 11 μm, about 12 μm, about 13 μm, about 14 μm, about 15 μm, about 16 μm, about 17 μm, about 18 μm, about 19 μm, or about 20 μm or anywhere in between.

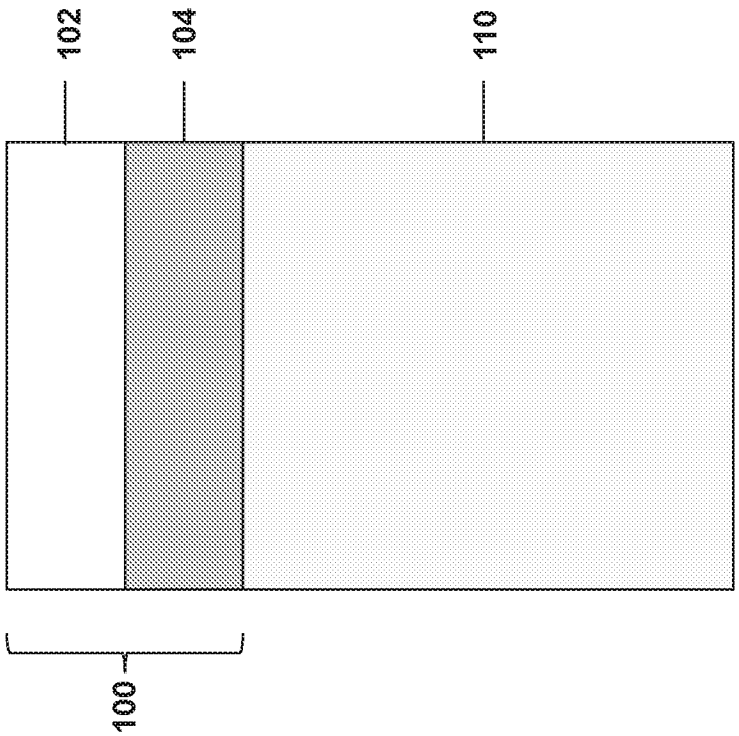

FIG. 1

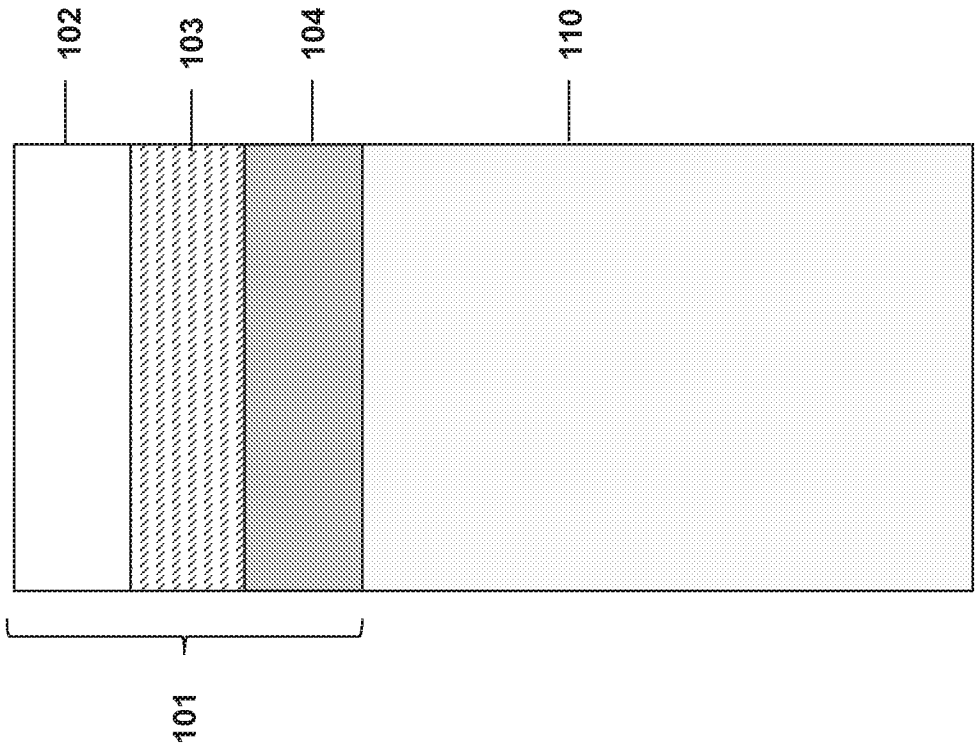

FIG. 2

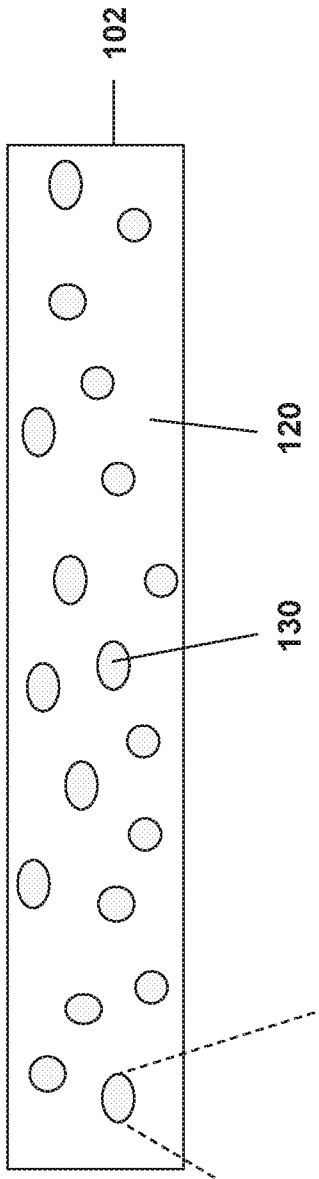

FIG. 3A

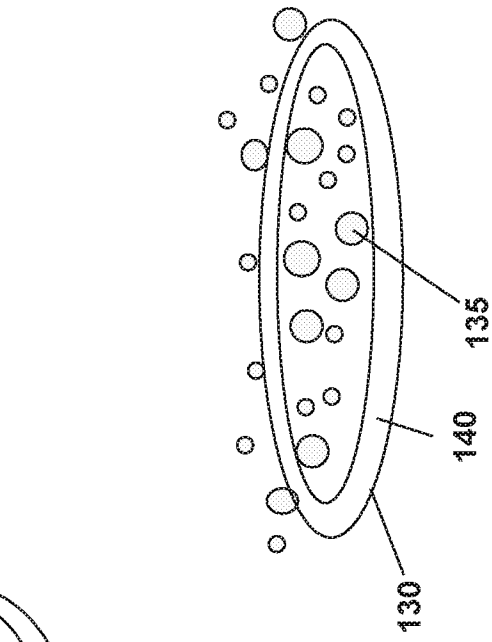

FIG. 3C

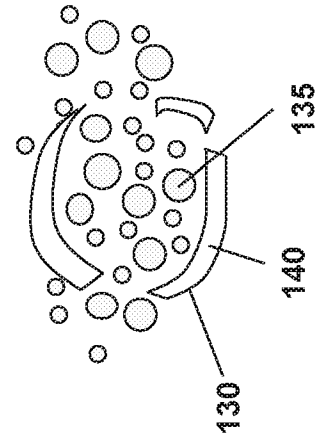

FIG. 3D

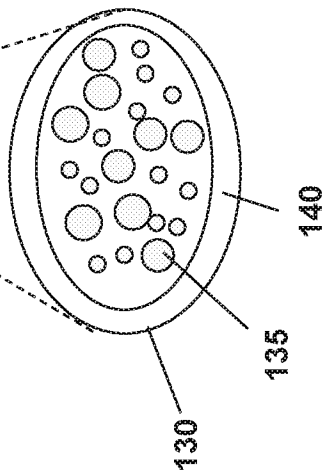

FIG. 3B